Swift 3-based application design and development

INTERACTIVE LEARNING APPLICATION FOR CHINESE MEDICINE

Interim Report

COMP4801 Final Year Project
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Submitted on January 22, 2017
1 ABSTRACT

In the project, an interactive learning application for Chinese Medicine will be developed, pursuing to be an ideal learning companion for students of Chinese Medicine with four major features: (1) Effectiveness; (2) Interactivity; (3) Creditability; and (4) Accessibility.

The application will feature an instant lookup functionality which provides accurate information instantly, and a revision reminder to enhance the memory retention of the information. An experiment was conducted with current students of Chinese Medicine, and it suggested that the application could significantly improve the efficiency of information lookup. User feedback will be continuously collected throughout the development process.

2 ACKNOWLEDGEMENT

I would like to express my appreciation to the group of students from School of Chinese Medicine, Li Ka Shing Faculty of Medicine, The University of Hong Kong for providing precious comments and participating in experiments during the development process. I would also like to thank my supervisor Dr. Yip Chi Lap, Beta for his constant encouragement and guidance, and for offering me such a valuable chance to sharpen my skills in project development and programming.
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6 BACKGROUND

Consider a scenario in which a student encounters a new terminology when reading a thesis. To learn its definition, he searches the phrase from various sources, compares different results, filters out irrelevant ones, and finally, acquires the new knowledge. However, soon after that, the acquisition of new knowledge starts to decay and eventually be forgotten.

This scenario, unfortunately, is a learning process that we may commonly experience. Scattered and varied information available on the Internet reduces the efficiency of acquiring new information. Existing solutions which aim to enhance the effectiveness of learning will be discussed and evaluated in the next section. However, none of them could instantly provide accurate and credible information, and meanwhile, preventing users from forgetting the information.

To address the situation, we plan to develop an interactive learning application for Chinese Medicine which allows users:

- lookup information about Traditional Chinese Medicine (“TCM”) instantly from anywhere without leaving the current application;
- browse acupoints and meridians interactively with a 3D body model;
- refresh acquired knowledge through quizzes and practices;
- receive revision reminders based on calculated interval

The application records all lookups by users and reminds them to revise regularly to ensure their memory retention. Learning effectiveness can be enhanced to a great extent with its lookup and revision features, with methodology discussed in Section 9.

The application could further implement for all fields of study if evaluated as helpful for learning. Weighing the complexity and amount of resources available, TCM is chosen as the first implementation of the application. Information of TCM is complex and often required explanations with interactive materials, and few credible sources of information are available currently.

Application prototypes and database structures were completed, and a group of TCM learners are invited to provide suggestions on functionality and design of the application, and participated in simple experiments that compare the learning effectiveness of current solutions and the application. User interface and basic features of the application will be implemented in the next stage, and feedback from TCM learners will be collected continuously to ensure the application is designed as the best learning companion for TCM students.

In the project, an interactive learning application for Chinese Medicine will be developed, with enhanced learning effectiveness, collectively defined by (1) the speed of information lookup and (2) the performance of retaining information.
7 EXISTING SOLUTIONS

7.1 ACUPUNCTURE – MERIDIANS AND ACUPOINTS

Acupuncture – Meridians and Acupoints is an iPhone application developed by School of Chinese Medicine, The Chinese University of Hong Kong for TCM students and other healthcare professionals to study acupuncture. The free application includes information and pictures of medians and acupoints.

Figure 7.1(A) shows the complete list of acupoints where users can obtain information of the acupoints, shown in figure 7.1(B), by browsing the list and tapping the corresponding entry. However, the searching process is considered to be tedious, and can be improved with a graphical searching method.

Advantages
- Credible information endorsed by registered TCM practitioners and professors
- Trilingual interface and contents for international learners
- Well organised information

Disadvantages
- Inconvenient and tedious lookup functionality
- Lack of bookmark features for subsequent retrievals

Figure 7.1. Screenshots of Acupuncture – Meridians and Acupoints iPhone application
7.2 QUIZLET

Quizlet is an online learning tool for academic subjects with a cross-platform flashcard and revision application. The tool costs HK$160/year, and it provides 6 learning functions with pronunciations and images. Users can choose from community-designed flashcards or create their own.

Advantages

- Efficient learning by refreshing memory

Disadvantages

- Explicit download or creation of flashcard decks required
- Lack of interactive materials to hinder memory

7.3 EVALUATION

Table 7.1 shows the functionality comparison of discussed solutions, Acupuncture – Meridians and Acupoints and Quizlet, where they both lack of information lookup functionality and revision reminder, which are considered important for information acquisition and revision.

The interactive learning application will combine the advantages of the two discussed existing solutions and provide useful features that are not altogether available in any existing application.

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<td>✔</td>
<td>✘</td>
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<tr>
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Table 7.1. Functionality comparison of existing solutions and the proposed application
8 OBJECTIVES

The objectives of the project are to develop an iOS application which:

- enhances effective learning (defined in Section 8.2)
- provides credible, organised, and regularly updated information related to TCM
- presents interactive materials
- actively log user lookup and practice history
- reminds revision based on the memory model
- provides interface and contents in multiple languages
- enables system-wide instant lookup
- is free

Two technical goals were set as the target of the application, to better visualise the learning effectiveness provided by its functionalities. With the application, users will be able to:

- lookup information with 5 screen taps or less, and within 10 seconds
- retain over 80% of the acquired information after 60 days

8.1 SCOPE

The goal of the project is to develop an interactive learning application for all areas of the Traditional Chinese Medicine which act as supplementary learning materials to enhance the effectiveness of learning TCM. With the relatively short span of the project, a major section of TCM, acupuncture including meridians and acupoints, is chosen to be implemented in the project schedule for demonstration and evaluation of the effectiveness of such application. Acupuncture is chosen to be implemented due to its importance and complexity among all TCM areas, which can be simplified to a great extent with an interactive presentation and design of the application.

8.2 EFFECTIVENESS

Enhancing the effectiveness of learning is to be of paramount importance among the project objectives, and this abstract measurement is collectively defined and quantified by:

- the speed of information lookup; and
- the performance of retaining information

8.2.1 Information lookup

A simple experiment was conducted with current students from School of Chinese Medicine, HKU, target users of the application. Participants were instructed to lookup a designated TCM terminology from different sources, time elapsed and screen tap counts are measured until they provided the correct definition of the phrase. Figure 8.1 illustrates the experiment result (in red, small dots) where a large number of screen taps and long durations are generally required.
The result suggests that information in textbooks and Acupuncture application are organised in a manner which does not favour students to perform a quick search, where they lack of an information lookup functionality.

To provide effective learning, the application attempt to reduce the effort in information lookup to under 5 screen taps and 10 seconds (illustrated in Figure 8.1 in green, larger dot) as the objective.

### 8.2.2 Information retention

Dotted line in Figure 8.2 shows the forgetting curve which hypothesises the decline of memory retention in time [1]. If an acquired information is not subsequent practised, the memory retention of the information may drop under 60% in less than 10 days and under 10% in around 60 days.

To provide effective learning, the application aims to assist users to retain over 80% of the acquired information after 60 days, as illustrated by solid line in Figure 8.2.
8.3 DELIVERABLES

Application source code

An iOS application written in Swift 3 programming language will be delivered, which can be installed on iPhones or iPads with firmware iOS 10.

Swift 3 programming language provides communication APIs including Lookup API and Notification API, which are essential for instant lookup functionality and revision reminder of the application.

Database

The application supports user learning profile and progress tracking by storing user profiles in an online database. The database will be delivered with the application for testing.

Unity project file

The 3D body model displayed on the application will be drawn and written in Unity and mapped to Swift. The Unity project file will be delivered with the application for reference.
9 METHODOLOGY

The architecture of the system (illustrated in Figure 9.1) consists of the following components:

Application
The application installed on user devices will constantly communicate with the server to store and retrieve the latest learning history of the user.

Server
The system server is responsible for exchanging information between user application and two databases, namely Knowledge Database and User Database. It will fetch data from User Database and implement algorithms to determine the information retention of user, thus decide an optimal revision schedule (discussed in Section 9.2.4) and send a revision reminder to user through Apple Push Notification Server.

9.1 CREDITABILITY

9.1.1 Cooperation with School of Chinese Medicine, HKU
To provide credible information for the application, we plan to invite cooperation with a professor from the School of Chinese Medicine, HKU. Throughout the development stages, comments will be collected from the professor for modifications in following deliverables, and contents will be proofread prior to the final deliverable.
9.1.2 Regular correction and update of information

Information in the application could be corrected or updated after releasing to the public. Information is stored in the Knowledge Database hosted in Amazon Web Service, and the application will automatically fetch the up-to-date information from the server.

9.2 EFFECTIVENESS

9.2.1 User profile

The application stores all lookup histories and practice performances in user profiles. User profiles are stored in the database and are used to calculate and determine the effective revision schedule for users. Users can synchronise their profile across multiple devices to learn everywhere, and they can opt-out from storing lookup histories for privacy concern.

9.2.2 Instant lookup functionality

With the implementation of Lookup API provided by the new released iOS 10, users can lookup TCM terminology directly from any third-party application, and retrieve the definition and explanation instantly without launching the application, as described in Figure 9.1. Users may (a) highlight a terminology from anywhere including webpages and electronic books, (b) selecting “Look Up” in the popup menu, and a NSUserActivity function will be send to the server with the lookup keyword and the device identification, (c) and brief information for the phrase is returned and displayed, where detailed information can be obtained in the full article in the application by tapping the box. The convenient way to lookup TCM terminology significantly enhanced the effectiveness of knowledge acquisition. Every lookup by the user will be recorded, and reminded for revision to ensure the memory retention.
9.2.3 Logged practice

The performance of each practice and revision will be recorded in the database to determine the memory retention. The application will implement the Leitner System [2] to design a set of contents for next revision or practice. Figure 9.2 illustrates the implementation of Leitner System with cards as an analogy of information, and cards will be sent to next box if the user correctly answered, or to the first box if failed. Each succeeding box represents a better memory retention, while the first group represents the worst.

9.2.4 Revision reminder

The application reminds user for revision by implementing the spaced repetition [3] to determine the review schedule. Figure 9.3 illustrates the projected forgetting curve with spaced repetition, maintaining over 80% of memory if regularly revised. The application implements iOS notifications API for sending revision reminders to users.

![Figure 9.3. Illustration of Leitner System](image)

![Figure 9.4. Projected forgetting curve with spaced repetition (in red, solid line), forgetting curve and objective of the application (in grey, dotted lines)](image)
9.3 INTERACTIVITY

9.3.1 Interactive 3D body model

Along with interactive materials including images and videos, a 3D body model with animation will be tailor-made for the application to present medians and acupoints distribution.

The 3D body model will be implemented with Unity Game Engine and mapped to Swift. Unity Game Engine provides convenient way to define reactions to different gestures applied on the 3D model including drag to rotate and pitch to zoom. These manipulation methods are considered direct and simple to lookup acupoints and meridians located around the body.

Location information of acupoints and meridians on the body model will be stored in PostgreSQL database with PostGIS plugin. PostgreSQL is an open-source database management system which is specialised in handling geographical information, and PostGIS plugin extends the power of 3D information processing of PostgreSQL. They are ideal for storing information for the 3D body model, as acupoints can be rendered as points and meridians as paths in the database.

9.4 ACCESSIBILITY

9.4.1 Universal application

The application will provide adaptive layouts for iPhone and iPad resolutions to utilise the screen real estates comprehensively.

9.4.2 Interface and contents with multiple languages

The application will provide interface and contents in Traditional Chinese, Simplified Chinese and English, to accommodate the needs of growing trend of international learners. Initial language will be determined by user's system language and can be changed anytime in the application preferences.
10 RESULTS

10.1 WORK COMPLETED

Following works were completed as the first stage of development:

- Simple prototypes of the application
- Initialisation of User Database
- Initialisation of Knowledge Database

![Figure 10.1. Experiment on screen taps and time duration required to lookup a terminology](image)

To evaluate the learning effectiveness of the latest application prototype, a group of 10 current TCM students from the School of Chinese Medicine, The University of Hong Kong were invited to participate in a simple experiment in measuring the effectiveness of the lookup functionality. Feedback from the students in the first stage were studied and set as the objective of the project.

In the experiment, students were instructed to lookup a provided TCM terminology by three methods: (1) TCM textbook; (2) Acupuncture – Meridians and Acupoints; and (3) the latest prototype of Interactive Learning Application. The duration and screen taps made will be recorded and analyse the effectiveness of the methods, with the results shown in Figure 10.1.

The application outperformed the two existing solutions in terms of both duration and screen taps count, with most of participants were able to look for the term within 25 seconds and 7 taps. We were delighted with the result and will further modify the algorithm to reach our goal of under 5 screen taps and 10 seconds.
10.2 DIFFICULTY

Defined in Section 8 the two measurements of learning effectiveness:

- the speed of information lookup; and
- the performance of retaining information

The speed of information lookup was successfully visualised in the experiment, however we found it difficult to measure the performance of retaining information. Figure 9.4 shows the forgetting curve with the designed revision schedule, which requires almost 60 days to completely inspect the effect of revision reminder. It requires a long period to visualise the performance of revision reminder in such circumstance.

As a solution, we decided to release a simple experiment demonstrating the same functionality and algorithm, but implemented with web technologies. Experiment participants will be invited to regularly participate the revision testing by themselves, and we hope a preliminary result can be retrieved in around 6 weeks.

10.3 NEXT STAGE

In the coming stages of the project, the application will be development in an incremental model. User interface and functionality will be designed as a implementation guideline. The application will be developed as the stage after following the guidelines in the previous stages.

The students will be involved throughout the development stages. They will be invited to experience every application build and provide comments on the application. The feedback collected from each release will be evaluated throughly, and will be set as the guidelines for the next release. The incremental development model with evaluation after each release can ensure the application is designed as the ideal learning companion for TCM students.
## 11 SCHEDULE

The project schedules from September 2016 to Mid-April 2017. The application development adopts the **incremental build model** with a deliverable in each of the 6 defined milestones, each providing more implementation and functionality. Table 11.1 shows the project schedule with current status, and testing will be conducted after each iteration, and TCM students and professors will be invited to test and provide feedback after Milestone 3.

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<th>Milestone</th>
<th>Description</th>
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<td><strong>2016</strong>&lt;br&gt;October 2</td>
<td><strong>Phase 1 Deliverables</strong>&lt;br&gt;- Detailed project plan&lt;br&gt;- Project website</td>
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<tr>
<td>by October</td>
<td><strong>Milestone 1</strong>&lt;br&gt;<strong>Project study</strong>&lt;br&gt;- Swift 3 programming language and APIs&lt;br&gt;- Unity game engine&lt;br&gt;- Journals on spacing effect and spaced repetition</td>
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<td>by November</td>
<td><strong>Milestone 2</strong>&lt;br&gt;<strong>Initial preparation</strong>&lt;br&gt;- Server and database setup&lt;br&gt;- User interface</td>
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<td><strong>Milestone 3</strong>&lt;br&gt;<strong>Preliminary app</strong>&lt;br&gt;- Browse and lookup functionality&lt;br&gt;- Practices and lessons&lt;br&gt;- Tester comments and feedback collection</td>
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<td><strong>2017</strong>&lt;br&gt;January 22</td>
<td><strong>Phase 2 Deliverables</strong>&lt;br&gt;- Preliminary implementation&lt;br&gt;- Detailed interim report</td>
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<td>by March</td>
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<td>April 16</td>
<td><strong>Phase 3 Deliverables</strong>&lt;br&gt;- Finalised tested implementation&lt;br&gt;- Final report</td>
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Table 11.1. Project schedule with current status
12 CONCLUSION

In the project, an interactive learning application for Chinese Medicine will be developed, with enhanced learning effectiveness, collectively defined by (1) the speed of information lookup and (2) the performance of retaining information, accompanying with credible information, and interactive learning features.

The application provides various features to achieve the enhanced learning effectiveness, with highlighted features include (1) Instant lookup functionality and (2) Revision reminder with memory model implementation.

Project study and preparation were completed as the first stage of the project. A group of TCM learners are invited to provide suggestions on functionality and design of the application, and participated in simple experiment that compare the learning effectiveness of current solutions and the application.

They will be involved throughout the development stages, by testing and providing feedback on each application build. Comments collected from each release will be evaluated thoroughly, and will be set as the guidelines for the next build. The incremental development model with evaluation by users after each release can ensure the application is designed as the ideal learning companion for TCM students, meanwhile discover any project limitation and application design flaw which may potentially affect the project schedule.
13 REFERENCES

